

1 **Improvements to loudspeaker driver assemblies**

2  
3 The present invention relates improvements to loudspeaker  
4 driver assemblies and in particular to driver assemblies  
5 with retaining elements for panel loudspeakers.

6

7 Panel loudspeakers are becoming increasingly popular due  
8 to their low profile, practicality, low cost and  
9 improving sound quality.

10

11 Various constructional arrangements are available on the  
12 market, the majority of which include a driver assembly  
13 having a transducer for converting an electrical current  
14 into mechanical, pistonic movement. For distributed mode  
15 acoustic radiators, a panel has several nodes of  
16 movement. The rigid attachment of the transducer  
17 components to the panel alters the behaviour of the  
18 panel. In addition, the majority of the available  
19 arrangements require secure, permanent attachment in  
20 order to achieve adequate acoustic response. Although  
21 several attempts have to solve the above problems have  
22 been made, they have limitations in their acoustic  
23 response and are relatively expensive to produce.

24

1 It would therefore be desirable to provide an improved  
2 driver assembly that obviates or at least mitigates one  
3 or more of the drawbacks of the prior art.

4

5 According to a first aspect of the invention there is  
6 provided a driver assembly for a panel loudspeaker the  
7 driver assembly comprising a voice coil, a magnet  
8 assembly, and a moulded retaining element for retaining  
9 the magnet assembly with respect to the voice coil,  
10 wherein the moulded retaining element defines a first  
11 surface adapted to be coupled to panel forming an  
12 acoustic radiator.

13

14 Preferably, the moulded retainer consists of an elastomer  
15 material.

16

17 Preferably, the assembly further comprises a  
18 substantially rigid planar member attached to the voice  
19 coil, the planar member being disposed between the voice  
20 coil and said first surface.

21

22 According to a second aspect of the invention there is  
23 provided a driver assembly for a panel loudspeaker  
24 comprising a voice coil, a magnet assembly, a retaining  
25 element for retaining the voice coil with respect to the  
26 magnet assembly, wherein the retaining element consists  
27 of an elastomer, and defines a first surface adapted to  
28 be coupled to a panel forming acoustic radiator.

29

30 Preferably, the elastomer is a hydrogel.

31

32 According to a third aspect of the invention there is  
33 provided a driver assembly for a panel loudspeaker

1 comprising a voice coil, a magnet assembly, a  
2 substantially rigid planar member, a retaining element  
3 for retaining the voice coil with respect to the magnet  
4 assembly, wherein the retaining element defines a first  
5 surface adapted to be removably coupled to a panel  
6 forming an acoustic radiator, and the substantially rigid  
7 planar member is attached to the voice coil and is  
8 disposed between the voice coil and said first surface.

9

10 Preferably, the retaining element consists of a hydrogel.

11

12 Optionally, the retaining element consists of silicone.

13

14 The retaining element may consist of a material having a  
15 Shore A hardness in the range 0 to 20.

16

17 The retaining element may consist of a material having a  
18 Shore A hardness in the range 5 to 15.

19

20 The retaining element may consist of a material having a  
21 Shore A hardness of approximately 10.

22

23 Preferably, the retaining element functions to retain the  
24 voice coil and the magnet assembly in a spatially  
25 separated relationship.

26

27 Preferably, the retaining element consists of a single  
28 moulded element.

29

30 Preferably, the first surface is adapted to be removably  
31 coupled to the panel forming the acoustic radiator.

32

1 Preferably, the magnet assembly comprises an axially  
2 extending central portion defining a first pole of a  
3 permanent magnet, a radially extending portion coupling  
4 the central portion to an axially extending magnetic  
5 shroud, the shroud defining a second pole of the  
6 permanent magnet, wherein the central portion and the  
7 shroud define a flux space therebetween.

8

9 More preferably, the voice coil extends into the flux  
10 space. The flux space may be annular.

11

12 Preferably, the retaining element comprises a disc  
13 defining the first surface. More preferably, the  
14 retaining element comprises a wall upstanding from an  
15 opposing surface of the disc.

16

17 Preferably, a volume defined by the retaining element  
18 accommodates the magnet assembly and the voice coil.

19

20 Preferably, the planar member is mounted adjacent said  
21 opposing surface of the disc.

22

23 Preferably, the wall has an inner diameter and an outer  
24 diameter, and the disc has a diameter greater than said  
25 outer diameter such that the disc defines a flange around  
26 the wall.

27

28 Preferably, said opposing surface of the disc is provided  
29 with one or more continuous ridges extending around the  
30 wall. More preferably, the continuous ridges are  
31 concentric with the wall.

32

1 Preferably, the wall is provided with a radially  
2 extending flange for engaging the magnet assembly.

3

4 Preferably, the outer diameter of the wall decreases in a  
5 direction away from the disc. The retaining element is  
6 therefore partially frusto-conical in shape.

7

8 According to a fourth aspect of the invention there is  
9 provided a retaining element for a panel loudspeaker  
10 driver assembly comprising a disc defining a first  
11 surface adapted to be removably coupled to an acoustic  
12 radiator, and a wall upstanding from an opposing surface  
13 of the disc and accommodating a voice coil and a magnet  
14 assembly in a spatially separated relationship.

15

16 According to a fifth aspect of the invention there is  
17 provided a method of mounting an acoustic radiator of a  
18 panel loudspeaker comprising the steps of:

19       locating a voice coil and a magnet assembly in a  
20       moulded retaining element, and;  
21       removably attaching a surface defined by the moulded  
22       retaining element to a panel forming the acoustic  
23       radiator.

24

25 Preferably, the surface is removably attached to the  
26 panel by being placed in contact with the panel.

27

28 More preferably, the surface is removably attached to the  
29 panel without auxiliary fixing means.

30

31 Preferably, the surface has adhesive properties.

32

1 According to a sixth aspect of the invention there is  
2 provided a method of manufacturing a driving assembly for  
3 a panel loudspeaker, the method comprising the steps of:

4 forming a retaining member by injection moulding,

5 and;

6 assembling a voice coil and magnet assembly in the  
7 retaining member.

8

9 There will now be described, by way of example only,  
10 various embodiments of the invention with reference to  
11 the accompanying drawings of which:

12

13 Figure 1 is a perspective sectional view of a driver  
14 assembly in accordance with an embodiment of the  
15 invention, having a portion removed to display  
16 internal components;

17

18 Figure 2 is a cross-sectional view of the driver  
19 assembly of Figure 1;

20

21 Figure 3 is a perspective view of the driver  
22 assembly of Figures 1 and 2;

23

24 Figure 4 is a perspective sectional view of a driver  
25 assembly in accordance with an alternative  
26 embodiment of the invention, having a portion  
27 removed to display internal components.

28

29 Referring to Figures 1 to 3 of the drawings, there is  
30 shown a driver assembly, generally depicted at 10,  
31 comprising a transducer 12 and a retaining element 13.  
32 The transducer 12 is of the moving-coil type, and  
33 includes a voice coil 14 and a magnet assembly 15.

34

1 The voice coil 14 consists of a hollow cylinder with a  
2 coil of conducting material secured thereto. Electrical  
3 connectors 16 are provided to provide electrical contact  
4 with a current source (not shown) via wires 17. The  
5 device is driven by alternating current (AC), and  
6 preferably has standard loudspeaker impedance  
7 characteristics (4, 6 or 8 Ohm) with power handling in  
8 the range from 0.5 - 100W.

9

10 The magnet assembly 15 comprises a substantially  
11 cylindrical metallic outer sheath 18, and a circular  
12 metallic back plate 20. The sheath 18 is provided with  
13 an inwardly extending lip 19 of lesser inner diameter  
14 than the main body of the sheath. Centrally mounted in  
15 the back plate 20, internally to the sheath 18, is a  
16 cylindrical permanent magnet 21, mounted to the back  
17 plate 20 at one of its ends. On the opposing (lower) end  
18 of cylindrical magnet 21, there is provided an axially  
19 extending metallic portion 22. The axially extending  
20 metallic portion 22 comprises a frusto-conical portion  
21 23, with outer diameter decreasing in a direction moving  
22 away from the back plate 20. The axially extending  
23 metallic portion 22 at its free end has a cylindrical  
24 portion 24 with greater outer diameter such that a flange  
25 is defined.

26

27 The geometry of the magnet assembly 15 is such that an  
28 annular air space 26 separates the inwardly extending lip  
29 19 and the cylindrical portion 24. The cylindrical  
30 portion 22 defines one pole of a permanent magnet (shown  
31 as N), and the inwardly extending lip 19 defines the  
32 opposing pole of a permanent magnet (shown as S).

1 Magnetic flux is therefore concentrated in the annular  
2 region 26.

3

4 The voice coil 14 is securely mounted to a rigid planar  
5 pad 28, substantially concentrically with the pad 28.

6

7 The components of the transducer 12 are accommodated in  
8 the retaining element 13, which is moulded from an  
9 elastomeric material, which is preferably a silicone  
10 hydrogel. In this example, the material has a Shore A  
11 hardness of approximately 10. It has been found that  
12 materials having a Shore A hardness in the range 5 to 15  
13 are particularly suitable, although materials with Shore  
14 A hardness in the range 0 to 20 could also be used  
15 effectively.

16

17 The retaining element 13 comprises a substantially planar  
18 disc 30 defining a planar (front) surface 31, and a  
19 circular surrounding wall 32 upstanding from an opposing  
20 (back) surface 33 of the disc.

21

22 The circular surrounding wall 32 has a varying outer  
23 diameter that decreases in a direction moving away from  
24 the disc 30. The retaining element therefore has a  
25 frusto-conical shape.

26

27 The disc 30 has a greater diameter than that of the  
28 surrounding wall 32, such that the disc defines a flange  
29 40 around the wall. The opposing (back) surface 33 is  
30 provided with a pair of continuous concentric circular  
31 ridges 42, located around the surrounding wall 32. The  
32 ridges 42 allow an increased degree of axial flexibility  
33 of the disc, while retaining a certain amount of

1 stiffness against flexing about diametric lines and/or  
2 chords.

3

4 The internal diameter of the retaining element 13 differs  
5 at different axial positions of the element in order to  
6 accommodate the different components of the transducer.  
7 The rigid pad 28 is placed adjacent the opposing surface  
8 33 of the disc, approximately concentrically with the  
9 disc and with the internal volume defined by the  
10 surrounding wall 32. The rigid pad is thus disposed  
11 between the voice coil and the disc 30. The rigid pad 28  
12 has a diameter less than the outer diameter of the  
13 surrounding wall 32, but greater than the inner diameter  
14 of the main portion 32a of the surrounding wall. A  
15 shallow annular slot 34 is therefore provided to  
16 accommodate the rigid pad 28. Preferably the depth and  
17 diameter of the annular slot 34 corresponds closely to  
18 the thickness and diameter of the of the rigid pad 28, in  
19 order that the retaining element holds the rigid pad  
20 reasonably tightly.

21

22 Behind the rigid pad 28 (moving in a direction from the  
23 front surface 31 of the disc to the back plate 20), the  
24 surrounding wall is provided with a portion of decreased  
25 inner diameter, such that an inwardly extending ring 36  
26 is defined. The inner diameter of the ring 36  
27 corresponds to the outer diameter of the voice coil 14.

28

29 The inner diameter of the main portion 32a of the  
30 surrounding wall 32 corresponds to the outer diameter of  
31 the sheath 18 of the magnet assembly 15. The magnet  
32 assembly 15 and the voice coil 14 are held by the  
33 retaining element in an aligned, spatially separated

1 relationship. The positioning of the components is such  
2 that the voice coil extends axially into the annular  
3 space 26 in the magnet assembly. The coil is therefore  
4 located in the region of concentrated magnetic flux.

5

6 At the back end of the surrounding wall 32, an inwardly  
7 extending ring 38 is provided to engage with a  
8 circumferential portion of the back plate. A central  
9 area of the back plate is exposed, and may protrude  
10 through the aperture defined by the inwardly extending  
11 ring 38. The aperture provides access to the internal  
12 components of the driver assembly. In conjunction with  
13 the physical properties of the hydrogel material, the  
14 geometry of the retaining element 13 allows the retaining  
15 element to be temporarily stretched to allow assembly of,  
16 access to and removal of the transducer components.

17

18 In use, the front surface 31 of the disc 30 is coupled to  
19 a panel 44 to be used as an acoustic radiator. The  
20 choice of a hydrogel material for the disc reduces the  
21 reliance on auxiliary fixing means, such as a mechanical  
22 fixing, bonding or adhesive. The planar front surface of  
23 hydrogel material has inherent adhesive properties  
24 arising from the chemical make up of the material. This  
25 adhesion is adequate for removably attaching the driver  
26 assembly a wide range of rigid panels without using an  
27 auxiliary fixing mechanism or agent. The driver assembly  
28 will remain securely attached to the panel during use,  
29 with excellent acoustic coupling. After use, or if the  
30 position of the driver assembly is to be changed, it can  
31 be removed from the panel by simply peeling or pulling  
32 the driver assembly away from the panel. The panel can  
33 be repositioned immediately in the same manner.

1  
2 When coupled to any of a variety of panels, the driver  
3 assembly to produce a distributed mode speaker with good  
4 acoustic response characteristics. Since the coil 14 is  
5 located in the annular space 26, at which the magnetic  
6 flux of the magnet assembly 15 is concentrated, the  
7 application of an alternating current to the coil imparts  
8 a relative axial movement between the coil and the  
9 magnet. The retaining element 13 limits the axial  
10 expansion of the driver assembly, in a rearward  
11 direction, and thus the relative movement manifests  
12 itself as an axial movement of the voice coil 14. The  
13 voice coil imparts movement to the rigid pad 28, which  
14 transmits the mechanical movement to the panel 44 via the  
15 disc 30.

16  
17 The geometry of the retaining element is such that it  
18 directs the major mechanical movement to the area where  
19 there is contact with the panel 44, improving the  
20 movement in this side of the drive assembly, and  
21 minimising or effectively cancelling the movement on the  
22 back side of it.

23  
24 Figure 4 shows a driver assembly in accordance with an  
25 alternative embodiment of the invention. This embodiment  
26 is similar to that shown in Figures 1 to 3, although it  
27 has constructional and geometrical differences.

28  
29 Figure 4 shows a driver assembly, generally depicted at  
30 50, comprising a voice coil 54, a magnet assembly 55 and  
31 a retaining element 53.

32

1 The magnet assembly 55 comprises a metallic outer sheath  
2 56, and a circular metallic back plate 60. The sheath 56  
3 has an outwardly extending rim 58 which separates  
4 frusto-conical back portion 57 and an inwardly extending  
5 lip 59 of lesser inner diameter than the main body of the  
6 sheath. Centrally mounted in the back plate 60,  
7 internally to the sheath 56, is a cylindrical permanent  
8 magnet 61, mounted to the back plate 60 at one of its  
9 ends. On the opposing (lower) end of cylindrical magnet  
10 61, there is provided an extending metallic portion 62  
11 with a shaped rim 64 defining a flange. As with the  
12 embodiment of Figures 1 to 3, the geometry of the magnet  
13 assembly 55 is such that an annular air space in which  
14 magnetic flux is concentrated.

15

16 Also as before, the voice coil 54 is securely mounted to  
17 a rigid planar pad 68, substantially concentrically with  
18 the pad 68, and the components are retained in the  
19 elastomeric retaining element 53. The retaining element  
20 53 comprises a substantially planar disc 70 defining a  
21 planar (front) surface, and a circular surrounding wall  
22 72 upstanding from an opposing (back) surface of the  
23 disc.

24

25 The retaining element, which preferably is a silicone  
26 material as described with reference to Figures 1 to 3,  
27 fits over and around the back portion 57 of the sheath  
28 58. In this example, the rim 58 is received in a groove  
29 in the retaining element. The cooperation of the rim and  
30 groove assists in the maintaining the components in an  
31 appropriate spatial relationship.

32

1 In contrast to the embodiment of Figures 1 to 3, the  
2 magnet assembly is provided with a bore 75 extending  
3 through the back plate 60, the magnet 61 and the metallic  
4 portion 62. In this example, the bore is concentric with  
5 the other components of the apparatus. Electrical  
6 connections (not shown) to the voice coil 54 to pass  
7 through the bore and out to the audio apparatus providing  
8 the audio signal.

9

10 The principles of operation of the embodiment of Figure 4  
11 are the same as those described with reference to Figure  
12 1 to 3.

13

14 One function of the hydrogel retaining element is the  
15 transmission of energy from voice coil vibrations, which  
16 have relatively large amplitude, to panel vibrations of  
17 relatively small amplitude across a bigger surface area  
18 of the panel. This is facilitated by the provision of a  
19 disc to give a large contact area between the driver  
20 assembly and the panel. Consequently, the driver  
21 assembly turns a larger proportion of the panel into a  
22 loudspeaker and therefore produces a high quality sound  
23 in the high, medium and low frequency ranges. Compared  
24 with prior art arrangements, the present invention  
25 performs particularly well in the mid- to low-frequency  
26 ranges.

27

28 In addition, the retaining element provides a flexible  
29 connection between the transducer and the panel, without  
30 restricting the vibrations of the panel in the same  
31 manner as many prior art systems.

32

1 In accordance with one embodiment of the invention, the  
2 driver assembly is manufactured by:

3 (i) forming a retaining element from a hydrogel  
4 by an injection moulding process  
5 (ii) assembling a transducer from a magnet  
6 assembly and a voice coil with the retaining  
7 element.

8

9 The rigid pad 28 could be inserted into the retaining  
10 element after injection moulding, or alternatively the  
11 injection moulding could take place around a pre-  
12 positioned rigid pad.

13

14 The present invention in its various aspects provides  
15 numerous advantages over the prior art arrangements.

16

17 Firstly, the flexibility of the hydrogel transmits  
18 mechanical movement of the transducer to the panel  
19 without constraining its own modes of movement, which  
20 ensures an accurate sound fidelity.

21

22 The flexible attachment allows movement at the contact  
23 point between the driver assembly and the panel  
24 mitigating panel stress and damage.

25

26 The assembly avoids the need for a spider for mounting  
27 the magnet assembly centrally with respect to the voice  
28 coil.

29

30 The retaining element aligns the movement of the voice  
31 coil, and minimises the stress to the coil and rattling  
32 caused by misalignment.

33

1 The retaining element aids heat dissipation and protects  
2 the panel from overheating.

3

4 The driving assembly is compatible with a wide range of  
5 rigid panels, due to the avoidance of bonding the  
6 transducer to the panel.

7

8 The improved alignment of the transducer parts allows  
9 manufacture of the transducer with a small annular space  
10 between the voice coil and the magnet assembly, improving  
11 transducer efficiency.

12

13 Due to the non-bonded attachment of the transducer to the  
14 panel, the weight of the panel is not supported by the  
15 drive assembly.

16

17 The driver assembly has the ability of produce high  
18 quality sound at frequencies of between 50 to 18000Hz  
19 using only one transducer.

20

21 The retaining element keeps all component parts together,  
22 but at the same time gives some flexibility to the  
23 structure of the product.

24

25 The driver assembly has improved load bearing  
26 characteristics.

27

28 The driver assembly and retaining element of the present  
29 invention is able to function on a wide range of surfaces  
30 such as foam tiles, display boards, metal, glass and  
31 plastics. The properties and the manufacturing process  
32 of the hydrogel render the unit flexible due to the way  
33 it is fixed to a panel within seconds and can be attached

1 and re-attached without damage to the panels/displays,  
2 and without an auxiliary fixing agent or mechanism.

3

4 The technology can be used wherever space is limited, or  
5 external access to transducer components is to be  
6 avoided. The flexibility of the assembly gives rise to  
7 numerous applications of the technology as follows:

8

- 9 • Audio/visual products.
- 10 • Ceiling tile installations.
- 11 • Hifi manufacturers/retailers.
- 12 • Mobile telephones.
- 13 • Boating and leisure industries.
- 14 • Vandal-proof requirements and security.
- 15 • Clean rooms.
- 16 • Military.
- 17 • ATMs, interactive kiosks.
- 18 • Mobile audio/concerts.

19

20 Particular applications to audio systems in public areas  
21 are envisaged, for example to advertising displays with  
22 audio capability. The driver assembly may be mounted to  
23 a rear surface of a display board, and connected to a  
24 source of audio data such as a combined MP3 player and  
25 amplifier. A proximity detector, such as an infrared  
26 detector, may be provided to activate the system in  
27 response to an indication that a person is in the  
28 vicinity of the display.

29

30 It will be appreciated by one skilled in the art that  
31 various modifications and improvements could be made  
32 within the scope of the invention herein intended.

33